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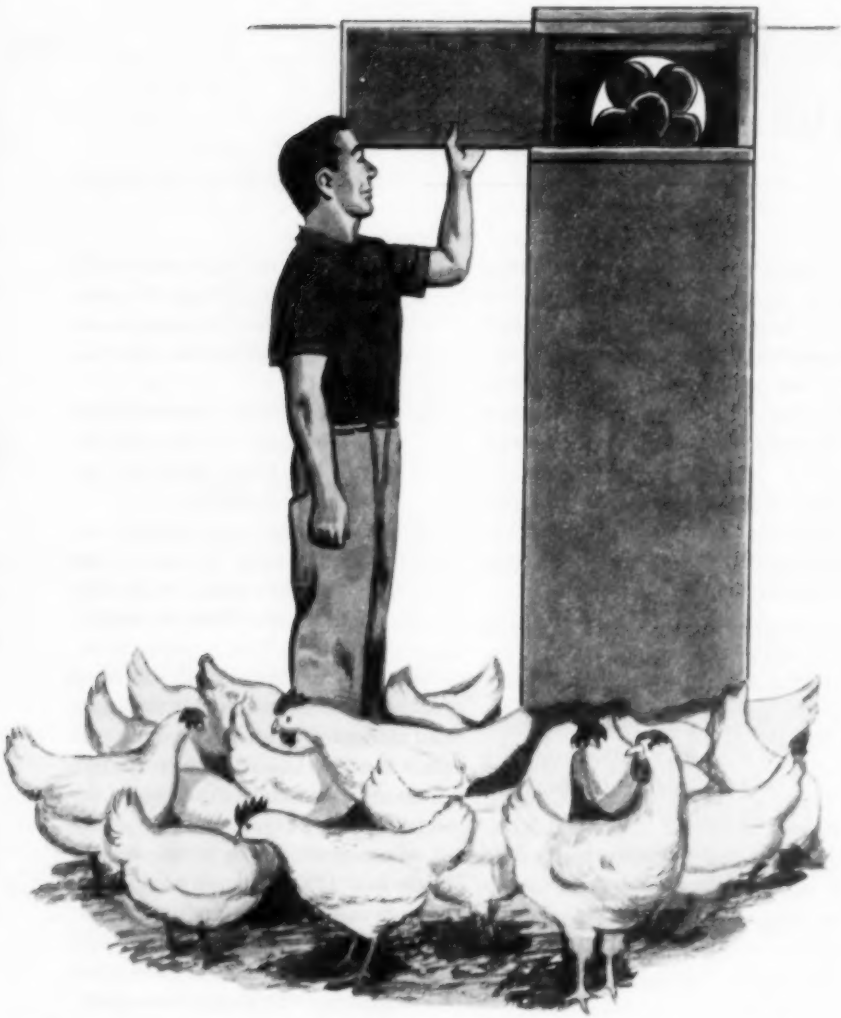

Ventilate Your Poultry House with ELECTRIC FANS

C. N. TURNER

Ventilate Your Poultry House with Electric Fans

By C. N. TURNER

A good ventilation system changes the air in the poultry house and thus helps to keep the flock healthy and insures maximum production. A system that uses an electric fan, to exhaust the stale moist air, and inlets, to provide fresh dry air, has proved reliable.

The properly designed and installed system should provide the following benefits to the poultryman during the colder months:

1. Provide a continuous supply of fresh air to help to keep the flock in good health.
2. Maintain a temperature above 30°F. and a relative humidity below 80 percent during the cold months.[1]
3. Reduce the labor required to ventilate the house.
4. Help to keep the floor litter dry, resulting in fewer dirty eggs, less labor, and more profit.
5. Retard the deterioration of the house by reducing the moisture and frost that forms on the walls, windows, and ceiling.
6. Prevent a high concentration of ammonia or dust in the air that often produces unhealthy conditions.
7. Prevent large temperature fluctuations and drafts in the house that often occur during periods of sudden weather changes.

Of the benefits listed, dry litter is probably the most difficult to obtain and is often the rule used to measure the success or failure of a ventilation system. The two main reasons for wet litter are: (1) the large amount of water given off each day by the birds and (2) the small amount of heat available in a poultry house. Floors on poorly drained soil and cold uninsulated floors over open sheds increase the damp litter problem.

Moisture Problem

To prevent an accumulation of moisture given off by the birds in the breath and in the droppings, the

[1] Research studies show that laying hens reach maximum production at a room temperature of 50° to 55°F. The highest feed efficiency is at a room temperature of 55° to 65°F. Authorities feel that brooder-room temperature should be maintained above 45° if possible.

ventilating system has to remove about 45 pounds, or 5½ gallons, of water from the house each day for a flock of one hundred 5-pound birds. For a 1000-bird flock, this means the removal of a 55-gallon barrel of water each day. During the coldest winter months, from 80 to 85 percent of this moisture is deposited in the droppings, either on the litter or in the droppings pit. Since the droppings are not normally removed each day, this moisture should be removed continuously by a ventilation system. The air cannot carry this moisture until heat has evaporated it.

Heat Problem

Since the amount of heat produced by a flock of birds is so small compared with that available from other livestock, every effort must be made to conserve it and to use it to evaporate the moisture and to ventilate the house. Heat generated in deep "built up" litter supplements that available from the birds and helps to evaporate the moisture from the droppings. To produce this heat, a 6-inch depth of litter should be started early in the fall and built up with the addition of finely chopped dry material to a total depth of 10 to 12 inches by mid-winter. This mixture of litter, droppings, and some moisture tends to promote bacterial and chemical action that produces some heat which helps to evaporate the moisture from the droppings. A fine, loose, friable litter is easiest for the birds to scratch and thus exposes the maximum surface to the drying air. Feeding grain in the litter and the use of hydrated lime both help to maintain a loose litter and to allow the moisture to move from the litter to the ventilating fan.

It is, therefore, essential that the poultry house be insulated enough to prevent this valuable heat from being rapidly lost through the floor, walls, and ceiling. This not only helps to keep the best temperature and humidity conditions for the birds but prevents the water system from freezing, helps to keep the frost from forming on the walls and ceiling, and provides a comfortable house in which to work. For the southern half of New York State, the insulation or resistance value (R) of the wall and ceiling should be at least 6; that for the northern half of the State, at least 10. Unless the house is well insulated, no assurance can be given that any type of ventilation system will keep the litter dry during the winter months of December, January, February, and March. Detailed information on the insulating values of different materials and the use of vapor seals in poultry-house construction are given in Cornell Extension Bulletin 714, *Heat Leakage in Farm Buildings and Dwellings*, by A. M. Goodman.

Other problems related to wet litter that cannot usually be handled by the ventilation system are the following:

1. Crowding too many birds into the available floor area—

the light breeds need from 2 to 3 square feet, heavier breeds from 3 to 4 square feet, and broilers ¾ square foot, of floor area for each bird

2. Excessive spilling and overflow at the drinkers
3. Open windows during storms
4. Lack of good drainage around the outside walls and under floors in contact with the ground [2]

A properly designed electric exhaust fan and intake system of ventilation allows the poultryman to close or adjust the windows, start the fan in November, and then make no further adjustments until next March. For brooder houses, the fan is started after the first or second week and only the thermostat needs adjustment afterwards. This system can provide many benefits even in cold (uninsulated) houses, and always assures maximum benefits in well-built warm (insulated) houses. Both the fan and the well-distributed inlet openings are essential for satisfactory operation. The use of only a fan in a window or the wall is seldom successful. Research studies have shown that a well-designed system can be simple, inexpensive, and effective.

Since many poultry houses are an individual problem, consult your Extension Agricultural Engineer, the County Agricultural Agent, or the Farm Service Representative from your electric-power supplier regarding your poultry-house ventilation problem.

[2] Refer to Cornell Extension Bulletin *451*, *Homes for Laying Hens*, by A. M. Goodman.

Exhaust Fan

There are many types and styles of fans. It is important to consider the purchase of an electric fan made by a well-known manufacturer and sold by a reliable local dealer. A low purchase price may not mean the lowest total cost over a period of years.

General recommendations for the selection and installation of one or more fans for an insulated house are the following:

1. Select your total fan capacity to exhaust from 3 to 4 cubic feet per minute (c.f.m.) for each 5 pounds of bird weight. For a two-fan or two-volume system, select a fan to exhaust about 1½ c.f.m. for each 5 pounds of bird weight for low-volume delivery. For *uninsulated* houses and single-volume delivery, use 2 c.f.m. for each 5 pounds of bird weight (table 1).

   The diameter of a fan cannot always be used in determining its capacity. The number, pitch, and shape of the blade, its position in the frame, and the speed, all effect the cubic feet per minute delivered at any given pressure. Therefore, only the manufacturer's rating should be used in selecting the correct unit.

Table 1. Capacity of electric fans (c.f.m.) for various types of systems

5-pound birds	One-fan, single volume*	One-fan, single-speed, two-volume system		Two-fan system		Minimum inlet§ openings	
		High volume†	Low volume through duct‡	High-volume fan	Low-volume fan	Single-volume system	Two-volume system
Number	*c.f.m.*	*c.f.m.*	*c.f.m.*	*c.f.m.*	*c.f.m.*	*Number*	*Number*
150	300	600	225	....	....	2	2
300	600	1,200	450	....	....	2	4
500	1,000	2,000	750	....	....	3	6
700	1,400	2,800	1,050	1,750	1,050	4	8
1,000	2,000	4,000	1,500	2,500	1,500	6	12
1,500	3,000	6,000	2,250	3,750	2,250	9	18
2,000	....	8,000	3,000	5,000	3,000	....	23
3,000	....	....	....	7,500	4,500	....	34

* One-fan single-speed single-volume delivery based on 2 c.f.m. for each 5 pounds of bird weight in *uninsulated* houses. Higher deliveries can be used to advantage for insulated houses or for southern counties in the state.

† These high volumes are based on 4 c.f.m. for each 5 pounds of bird weight.

‡ These low volumes are based on 1½ c.f.m. for each 5 pounds of bird weight.

§ The number of inlets is based on a 60-square-inch opening such as the box type or window type of inlet.

2. Install at least one fan in each pen to operate continuously during the entire winter period. Moisture is given off by the birds continuously and intermittent (on-off) operation allows the moisture to accumulate in the house and on the litter.
3. Install at least one fan for each pen in a duct that extends to within 15 inches of the top of the litter (figure 1). By placing the fan in the wall near the ceiling and installing a duct, it is possible to exhaust the cooler air from the floor during cold weather and the warmer air from the ceiling in warm weather.
4. Select a fan that has proved to give long, trouble-free service. The blades should be corrosion-resistant, self-cleaning, and strong enough to resist bending and to prevent vibration. A vibrating fan blade soon destroys both itself and the motor bearings.
5. Use a single-speed motor of either the split-phase or the capacitor type. These motors tend to maintain their rated speed when operating the fan against ordinary wind pressure. Shaded pole types of

motors generally do not maintain their speed under similar conditions, they are less efficient, and are difficult to protect against "burn out" with current limiting overload devices.

Select a motor with a "built in" thermal overload device, or better still install a thermal overload switch or a safety switch with a time-delay fuse.[3] These overload devices reduce the possibility of damage to the motor and of a fire hazard in the event of abnormal operating conditions. Select a totally enclosed type of motor frame to protect the motor from dust, and keep the outside clean to prevent over-heating. To eliminate frequent lubrication, be sure the motor has ball bearings or a large oil reservoir that needs to be oiled only once a year.[4]

6. The fan and motor assembly should be capable of delivering *some air* against ¼-inch static pressure but can be selected on the basis of its *zero static pressure rating*.

Types of Fan Systems

The air deliveries of the various systems needed to ventilate different sized pens with different types of controls are given in table 1. One of the following three general types of systems may be selected:

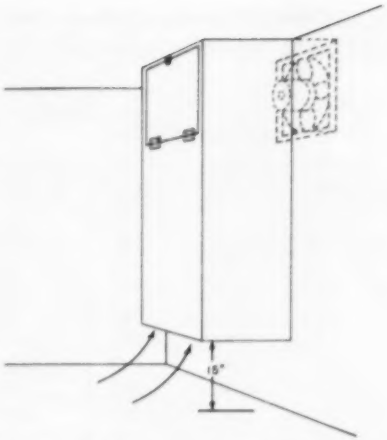

Figure 1. The one-fan, single-volume system, with a duct

The system operates continuously. The door in the top of the duct is for servicing the fan; it may also be opened in mild weather to help cool the house.

One-fan, single-volume

The single-speed fan installed in a duct (figures 1 and 2) is the simplest and least expensive system that has given satisfactory results. It is especially well adapted to the small flock or to the cold uninsulated house where the inside temperature tends to follow that of the outdoor air. No thermostat control is used because the fan operates continuously and draws the cooler air from the floor in cold weather and the warmer air from the ceiling in warm weather. The exhaust duct, extending to within 15 inches of the floor litter, with a hinged or sliding door, con-

[3] Refer to Cornell Extension Bulletin 673, *Protection for Electric Motors*, by E. S. Shepardson.

[4] Refer to Extension Bulletin 848, *Care of Electric Motors*, by F. B. Wright.

Figure 2. Exhaust fan in sidewall near ceiling, with duct extending to within 15 inches of the floor litter

Sliding door is for cleaning and oiling the fan and to exhaust air from near the ceiling during late fall and early spring.

trols the air flow (figure 2). Select the fan on the basis of 2 cubic feet per minute for each 5 pounds of bird weight in the pen (table 1).

Single-fan, two-volume

The single-fan, one-speed, two-volume system (figure 3) provides a more uniform temperature in the house and uses a smaller exhaust duct than the single-fan, one-volume system. The low-volume delivery provides enough ventilation for cold weather or when brooding small chicks, and helps to maintain a warm temperature in the house. High-volume delivery occurs only when the house temperature is above the thermostat control setting to remove the excess heat and moisture. The low volume exhausts the cooler air from the floor level through a small duct, and the high volume exhausts the warmer air through a controlled shutter or louvre at the ceiling level.

Install the fan in the wall of the pen at the ceiling, with the restricted duct extending to within 15 inches of the floor litter. Install a shutter, operated by a damper motor, directly behind the fan. The damper motor, controlled by a thermostat, opens the shutter for high-volume delivery at ceiling level when the air temperature in the house is above the thermostat setting. When the house temperature falls below the thermostat setting, the shutter closes, and restricts the air flow through the small duct from the floor level. This low-volume delivery of the cooler air in the pen provides a continuous flow of fresh air for the birds and removes some moisture without seriously lowering the pen temperature.

The *small duct* used with this system is usually about 4 inches deep and as wide as the fan frame (figure 3). A larger duct may be used if the fan manufacturer has provided the correct size of restricted opening or shutter control in the fan housing to give the desired low-volume de-

livery. A duct can be home built or purchased with the fan. A small damper in the duct may be desirable to restrict further the low-volume delivery for extreme cold weather and for small chicks. Some manufactured units provide thermostatically controlled shutters for three-volume delivery for wide ranges in air flow. With these units, the duct is usually full size from floor to ceiling.

The fan and motor assembly should be designed to prevent overloading on the low-volume operation because the restricted flow with this system increases the pressure on the fan. This should not be a problem with a fan rated to deliver some air against ¼-inch static pressure.

The single-fan two-volume system has all the advantages of continuous ventilation, such as (1) a supply of fresh air for the birds at all times, (2) removal of moisture that is continuously given off by the birds, (3) lower ammonia concentration in the air of the pen, and (4) elimination of the shutter and fan-blade freezing during cold weather that is common with all "on-off" intermittent operating fans.

This system usually costs less to purchase and install than an equal air flow with a multiple-fan installation. It is limited, however, to the practical size of one fan and, in some installations, the size of the fan is limited by the framing construction of the house.

Select the fan unit to exhaust about 4 cubic feet per minute on high volume and about 1½ cubic feet per minute on low volume for each 5 pounds of bird weight (table 1). Since the fan delivery is controlled by the thermostat setting, it works well in either an insulated or un-

Figure 3. The single-fan, single-speed, two-volume exhaust unit

This provides uniform temperature control. The motor-operated shutter behind the fan is controlled to open to reduce pen temperatures and to close to keep the pen warm in cold weather.

insulated house; the litter and air conditions will, however, be better in the house with the warmer construction.

Two-fan, two-volume

For large pens of birds, such as 2000 or more, the two-fan system is best (figure 4). A small fan operates continuously and a larger fan operates intermittently on a thermostatic control. If you want more than two-volume delivery, install additional fans and control them by thermostats with different temperature settings. More than two fans may be best in large houses to prevent cutting large openings in the sidewall of the house. Install all multiple-fan units at one location in the house to provide the same air-flow pattern throughout the house regardless of the number of fans operating.

The small continuous-running fan should be installed in the wall at the ceiling with a duct extending to within 15 inches of the floor litter. This provides a low-volume delivery of the cooler air from the floor during extreme cold-weather periods (figures 1 and 2). You may open the hinged door during warm weather to increase the exhaust of the warmer air. The door also gives access to the fan and motor for cleaning and oiling. A shutter is not needed on this fan because it runs continuously.

The larger thermostatically controlled fan should be installed in the wall at the ceiling beside the small fan, but it does not require an exhaust duct (figure 4). It operates when the temperature in the house rises above the thermostat setting. A two-degree differential in the control appears to be satisfactory for most installations. Install an automatic gravity-operated shutter behind this fan to prevent cold drafts when the fan is not operating. Usually there is less trouble from freezing if the shutter is inside the house, and it is easier to keep the shutter clean than if it is outside the house.

Select the small fan to deliver about 1½ cubic feet per minute and the large fan about 2½ cubic feet per minute for each 5 pounds of bird weight (table 1). If you want a lower delivery during extremely cold weather or when the chicks are small, install a damper in the exhaust duct on the small fan to restrict the air flow to any minimum flow required during such periods.

Location of Exhaust Fans

Whenever possible, place the fan or fans in the sidewall of the house away from the prevailing wind and in the wall that is the tightest (this is often the wall with the fewest windows). In general, the exhaust location should be in the center of one of the long walls of a rectangular house or pen.

If the fan is in the wall toward the prevailing wind, it should be capable of delivering some air against ¼-inch static pressure and be of the non-overloading design. Many lower price fans are designed for free air delivery and slow down when operating against wind pressure. When

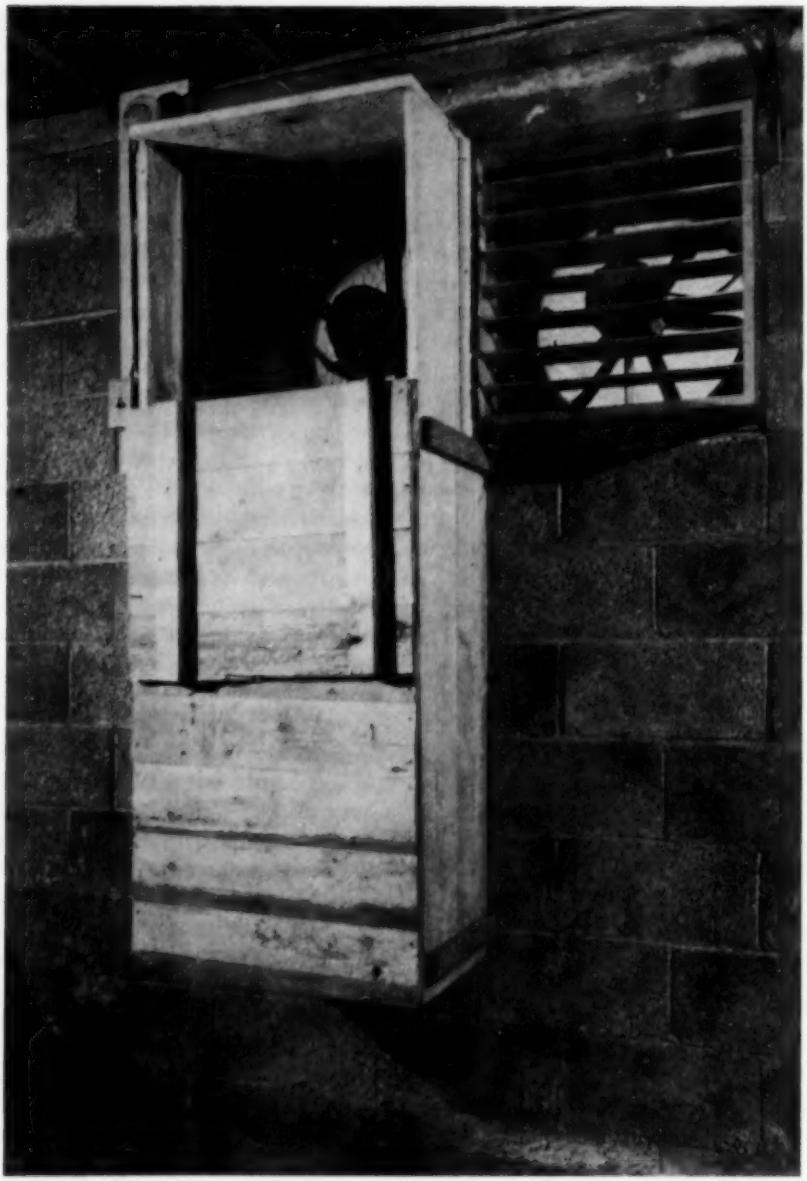

Figure 4. The two-fan, two-volume exhaust system with a duct on the fan that operates continuously

And a gravity shutter on the fan that operates on thermostatic control.

a fan slows down, the motor is usually overloaded and may burn out. Proper thermal overload protection may save the motor, but the birds will be without ventilation each time the fan stops.

Install the exhaust fan as far away from a door or a large window area as possible. A considerable amount of air leaks into the house at these openings and takes a short-circuit path to the exhaust fan, absorbing little moisture. Install all fans near the ceiling for the best control of air flow and to prevent an excessive amount of dust, litter, and feathers from entering the fan. This location also helps to protect the fan from damage by birds, animals, or children.

Construction of the exhaust duct

On all continuous-operating fans an exhaust duct helps to conserve the heat in the house by removing the cooler air at the floor. The restricted duct used on the single-fan, two-volume system should be designed to fit the fan, and the recommendations of the fan manufacturer should be followed. The full-size duct used on the single-fan one-volume system and the continuous operating fan of the two-fan system should be constructed to cause as little resistance to the air flow as possible. The area and suggested dimensions are given in table 2 for fans of different air delivery ratings.

The duct should be made of a tight building material such as matched lumber, plywood, cement asbestos or insulating board, or metal. Prefabricated ducts can sometimes be purchased from the fan- or ventilating-equipment manufacturer.

A hinged or sliding door at the top of the duct behind the fan is

Table 2. Capacity of fan, area of duct, and minimum inside dimensions of duct

Capacity of fan	Approximate area of duct	Suggested minimum inside dimension of duct
Cubic Feet per minute	*Square Inches*	*Inches*
300 to 600	150	10 by 15
600 to 900	242	11 by 22
900 to 1,200	344	12 by 29
1,200 to 1,500	420	13 by 32
1,500 to 1,800	500	14 by 36
1,800 to 2,400	605	16 by 38
2,400 to 3,000	760	18 by 42
3,000 to 3,600	910	20 by 46
3,600 to 4,200	1,055	22 by 48
4,200 to 4,800	1,190	24 by 50
4,800 to 5,400	1,325	26 by 51
5,400 to 6,000	1,445	28 by 52

necessary to service the fan and for late fall and early spring operation.

The exhaust fan in a good ventilating system should perform the following essential functions:

1. Remove the dust, ammonia, and moisture-laden air from the house continuously as it is produced by the birds.
2. Produce a partial vacuum in the house into which fresh air may flow through the intake system to keep the flock healthy.

Fresh Air Supply

In addition to the exhaust fan, an equally important part of any good ventilation system is the inlet openings. While the fan creates the low pressure in the house that makes the inlet system work, it should be emphasized that the incoming air provides the necessary supply of oxygen for the birds and picks up the moisture that needs to be removed from the house.

Properly designed and located inlet openings are essential to the control of the fresh, cool air supply to the house. To distribute and proportion the fresh, cool air to all parts of the pen without drafts, uniformly space inlet openings in all the walls but not closer than from 8 to 10 feet to the exhaust fan. Several types of intake openings have proved satisfactory, although some are more easily adapted to a particular type of house construction.

Figure 5. A box-type inlet
This inlet spreads a thin layer of air in a fan-shaped pattern close to the sidewall. The cool air helps to keep the wall dry, insulates against heat loss from the pen, and prevents drafts.

Box-type inlet

The "built in" box-type of inlet has been successfully used for many years (figure 5).[5] It should be installed with the top opening to the pen about 12 to 18 inches below the ceiling. The inside dimensions of the opening should give an area of 60 square inches (as, 3 by 20, 4 by 15, or 5 by 12 inches). The 1-inch slot at the sides and across the top spreads the incoming air in a thin layer along the wall in a fan-shaped pattern, upward and to the sides. Close the hinged lid on top in cold weather. You may open it during late fall and early spring. One inlet opening is recommended for each 350 cubic feet per minute of total fan capacity

[5] This inlet was developed by Professor A. M. Goodman for broiler houses.

of the system. (In houses that have flue-vented brooder stoves, use the full number of inlet openings to prevent back drafts with a fan-ventilation system.)

The baffle-board inlet

For masonry block walls, place a baffle board on the inside of an opening straight through the wall (figure 6). This is inexpensive and effective. To make the opening, lay a block with the core openings horizontal instead of vertical. Use four threaded rods or bolts to anchor the baffle to the wall to hold and adjust it. The baffle should extend about 12 inches beyond the opening in all directions to direct the air close to the wall in a thin layer. A space of about 1 inch between the baffle and the wall is suggested, but you can make adjustments for the amount of fresh air needed in any particular area of the pen. The thin layer of cool air flowing close to the wall helps to keep it dry and provides some insulating effect by reducing the heat loss from the inside air through the wall.

The material for the baffle board can be matched lumber, plywood, pressed fibre, or cement asbestos board. Provide one inlet of this type for each 250 cubic feet per minute of total fan capacity of the system.

The window inlet

Windows may be adapted to provide inlet openings if they are in the desired inlet locations for the house (figure 7). The opening may be at the top or the bottom of the sash. Raise or lower the sash from $1\frac{1}{2}$ to 3 inches, depending upon the width of the window, to provide the 60 square inches of inlet area. Place a baffle board directly in front of the opening to direct the air downward or up-

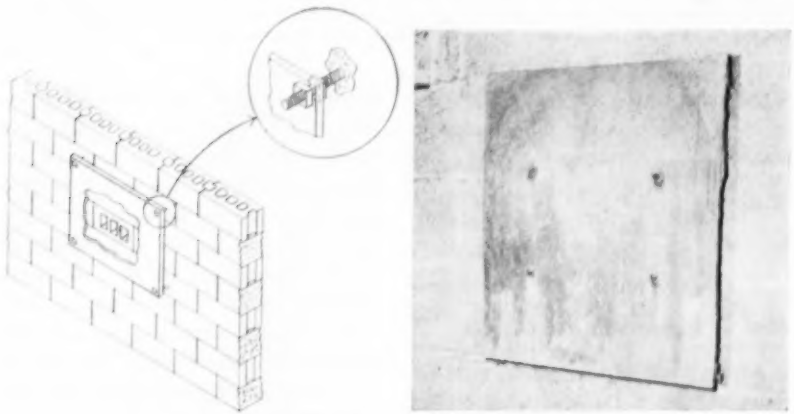

Figure 6. A baffle-board inlet for masonry walls
The thin layer of cool, dry air flows close to the wall, keeps it dry, insulates against heat loss, and prevents drafts.

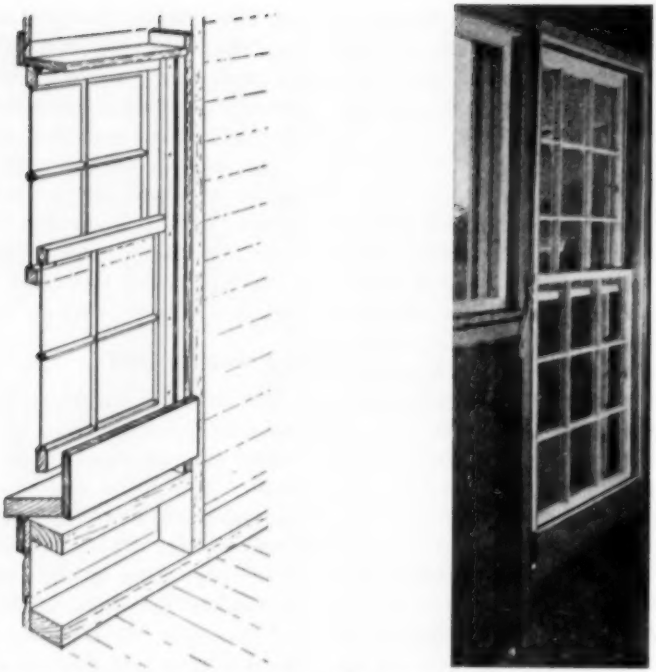

Figure 7. Cross-section of a window-type inlet with baffle board installed to direct air upward

The thin layer of cool air helps to keep the window dry, insulates against heat loss, and prevents drafts. The window may be lowered from the top and the baffle board placed in front of this opening if the building is used as a laying house.

ward close to the window. The flow of air parallel to the glass helps to keep it dry and tends to reduce the heat loss from the house.

The same number of inlets should be used as for the box-type inlet (table 1).

Slot or bored-hole type inlet

A new type of inlet developed for dairy stables [6] can also be used for single-story poultry houses and sometimes for the top floor of multistory houses. The slot design can be incorporated in the construction of a new house (figure 8), or it can sometimes be installed in a building already constructed. A slot, or sometimes a series of bored holes, provides an inlet opening from the attic space above directly to the pen at the junction of the ceiling and the sidewall. The slot or holes extend all around the pen except for a distance of 2 feet from the exhaust fan. The

[6] This inlet was developed by Professor W. F. Millier.

slot or bored-hole inlet cannot be used with a complete "on-off" intermittent-operating exhaust system because the moist air from the pen would flow upward into the cold attic space and condense on the roof whenever the exhaust system stopped.

A slot approximately ½ inch wide has proved satisfactory for poultry houses and twenty-five 1-inch holes or fifteen 1¼-inch holes are needed for each 100 cubic feet per minute of exhaust-fan delivery.

Inlets control temperature and moisture

The amount of inlet opening in different parts of the house has an important effect upon the temperature in that area. If an area is cold, you may restrict the inlet opening to reduce the amount of cold air entering this part of the pen. If an area is damp, you increase the inlet opening to provide more cool dry air for this part of the pen. Some fresh air should enter all areas to replace the moisture-laden air and provide favorable conditions for the use of the entire floor area for the birds.

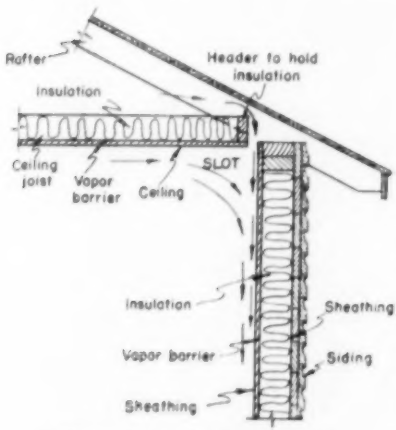

Figure 8. A slot-type of inlet
This inlet allows air to enter the house from an attic space.

Pressurized Systems

The author's experiences with ventilating systems designed to force air into the house with the fan have been unsatisfactory. This creates a positive pressure in the house that causes the moisture from the birds to move through the structure and condense on its way out. During cold weather, the doors and windows freeze tight and frost appears under the roof in attic spaces. The moisture soon loosens the paint from the siding, and reports of research have shown that the insulation becomes wet in the walls. Therefore, this system would seem to be undesirable for the climate found in most parts of New York State.

Summer Ventilation

The need for ventilation of the poultry house in summer is usually to keep the birds cool. The system described here is designed merely to remove moisture in winter; it cannot be expected to cool the birds in summer. It is possible that the same fan units might be turned around to direct air into the pen and move the air around the birds to make them more comfortable.

No ventilating system can cool the air in a house unless the outside air is cooler than the inside air. There-

fore, circulation of air within the house appears to be the best solution, and large fans are usually required to do this effectively. To remove the heat produced by the birds and to provide the same temperature in the pen as that outdoors may require an exhaust fan capacity from three to four times that required for a winter ventilating system.

Requirements of a Successful System

Success with a poultry-house ventilation system means:

1. The house should be well-built and insulated to conserve the relatively small amount of heat available from the birds that is so necessary to evaporate the moisture from the droppings before it can be removed by the ventilating system.

2. The drinking devices should prevent the birds from throwing water onto the litter, and a drainage system is needed to catch and remove any excess moisture from the house to prevent damp litter.

3. A built-up litter of fine broken absorbent material generates some heat to evaporate moisture from the droppings, to store some of the moisture from the droppings during poor drying periods, and to allow the birds to work it over for the release of this moisture during good drying periods. When pullets are housed late in the fall, a fresh deep litter is needed but there is no assurance that it can be kept dry. A mixture of droppings and fine broken litter is necessary to generate the heat needed for evaporation of the moisture to the ventilating air.

4. Crowding too many birds in a limited floor area results in condemnation of the ventilating system. About 3 square feet of floor space is recommended for each leghorn hen, 4 square feet for a heavy bird, and ¾ square foot for each broiler. This floor area can be slightly less for large square pens.

5. A high-priced fan may turn out to be a low-cost investment if dependability and fire hazard are considered.

6. The system recommended in this bulletin is not designed to cool the poultry house and, therefore, cannot be considered adequate for summer ventilation.

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